

ZOOLOGER

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ZOO GOER

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The Shilluk peoples of Malakal, Sudan, fashioned this hyena-shaped pipe bowl out of terra cotta and pigment.

Photograph by Franko Khoury, National Museum of African Art, Eliot Elisofon Photographic Archives, Smithsonian Institution

6 SEX AND THE SPOTTED HYENA

Robin Meadows

Once labeled hermaphrodites, female spotted hyenas are now being looked at in a new light. Hyena females rule the roost, even controlling the destiny of future generations. Here's almost everything you ever wanted to know about sex and the spotted hyena, but might not have known to ask.

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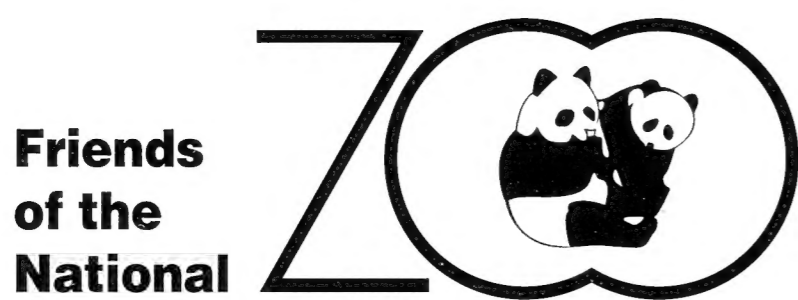
Jeffrey P. Cohn

In some areas where wild habitats are being transformed into suburbs, highways, and malls, military properties have become a last bastion of biodiversity. A number of highly effective conservation programs are run on bases, benefitting wildlife while not hindering the military's use of the land for its purposes.

23 PATERNITY SUITS THEM

Robin Meadows

Mothers don't do all the work in the animal kingdom. Fathers pull their weight in a variety of species, proving that sometimes the best mom is a dad.



is a nonprofit organization of individuals, families, and organizations who are interested in helping to maintain the status of the National Zoological Park as one of the world's great zoos, to foster its use for education, research, and recreation, to increase and improve its facilities and collections, and to advance the welfare of its animals.

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Director: Michael H. Robinson.

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CALL FOR NOMINATIONS

Dear Member:

Each year, in accordance with our By-laws, the Board of Directors of Friends of the National Zoo solicits nominations from the membership. Our volunteer Board plays an essential role in the leadership and operation of FONZ, and we rely on our members to recommend people with appropriate skills and talents to assist our efforts to support our great Zoo.

I ask you to help by nominating to the Board persons who are interested in this very special community service. You may also nominate yourself.

Nominations will be reviewed by the Board's Nominating Committee. The names of selected candidates will be forwarded to the membership for election.

The criteria by which potential candidates are judged for nomination to the Board of Directors include: the candidate's strong interest in supporting zoological education, research, and conservation in accordance with the purposes of our corporation; leadership; experience or skills that are needed and that would directly benefit the management and operations of FONZ; and the willingness to commit significant amounts of time to participate fully in FONZ work and activities. Candidates must also be dues-paying members of FONZ.

Much of the Board's work is accomplished through committees. For example:

The **Education Committee** makes policies and provides guidance for FONZ-supported education, conservation, outreach, and Zoo-support programs.

The **Membership Committee** develops policies related to membership activities and provides oversight for membership acquisition and retention programs.

The **Visitor Services/Concessions Committee** formulates policies for FONZ concessions operations and visitor support services.

Other Board Committees or Subcommittees include: Administration, Capital and Strategic Planning, Development, Finance and Audit, Nominating, ZooFari and Special Events, and Publications.

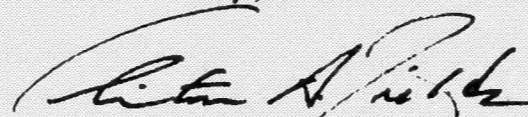
All Board members are expected to serve on at least two committees and attend two or more meetings or functions each month.

Nominations may be made only by dues-paying members and must be submitted on an official FONZ Nomination Form with a biographical sketch of the nominee.

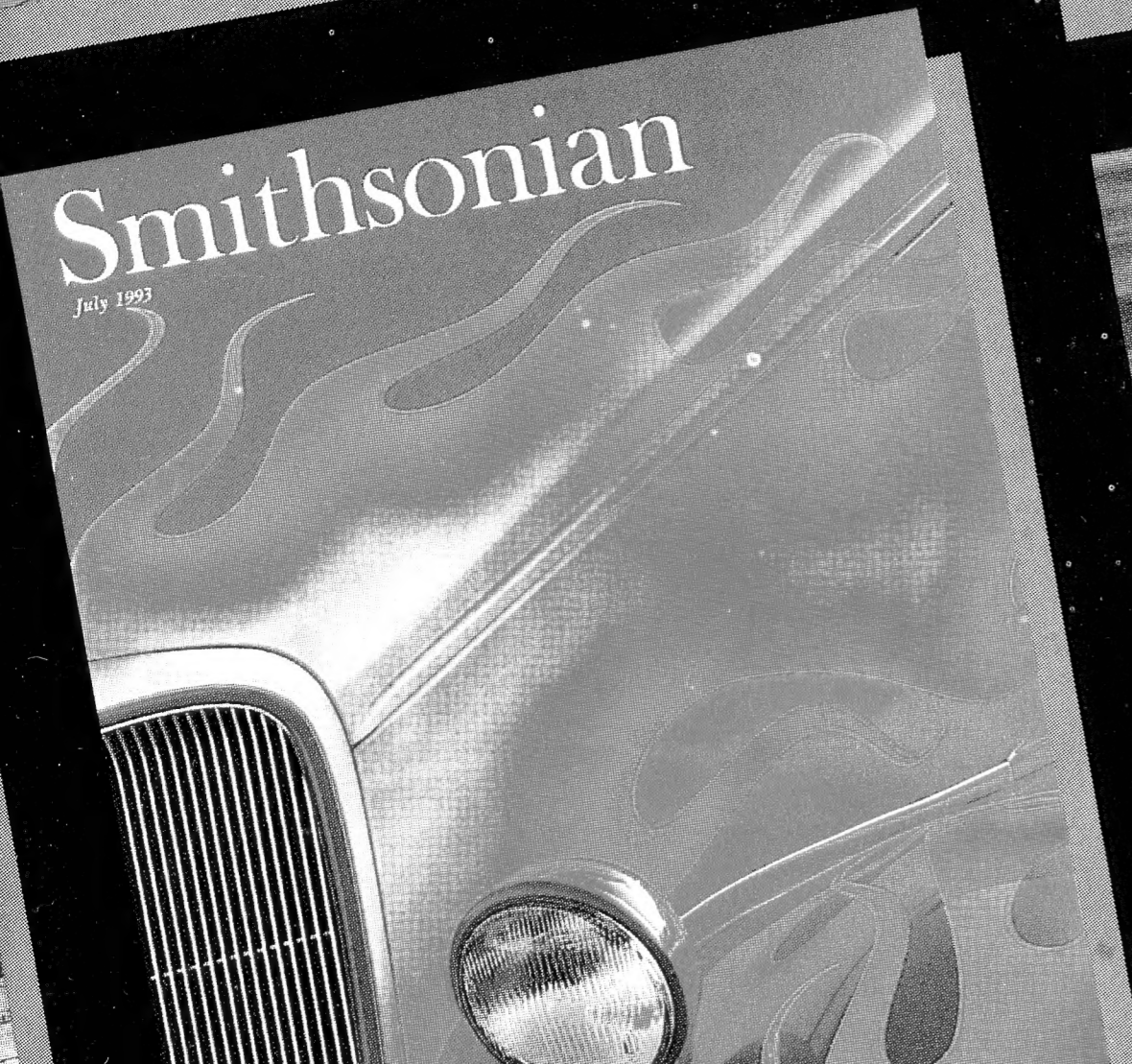
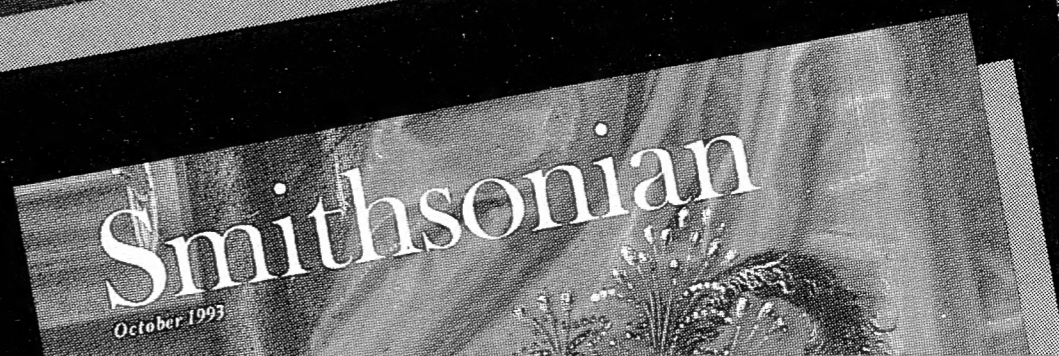
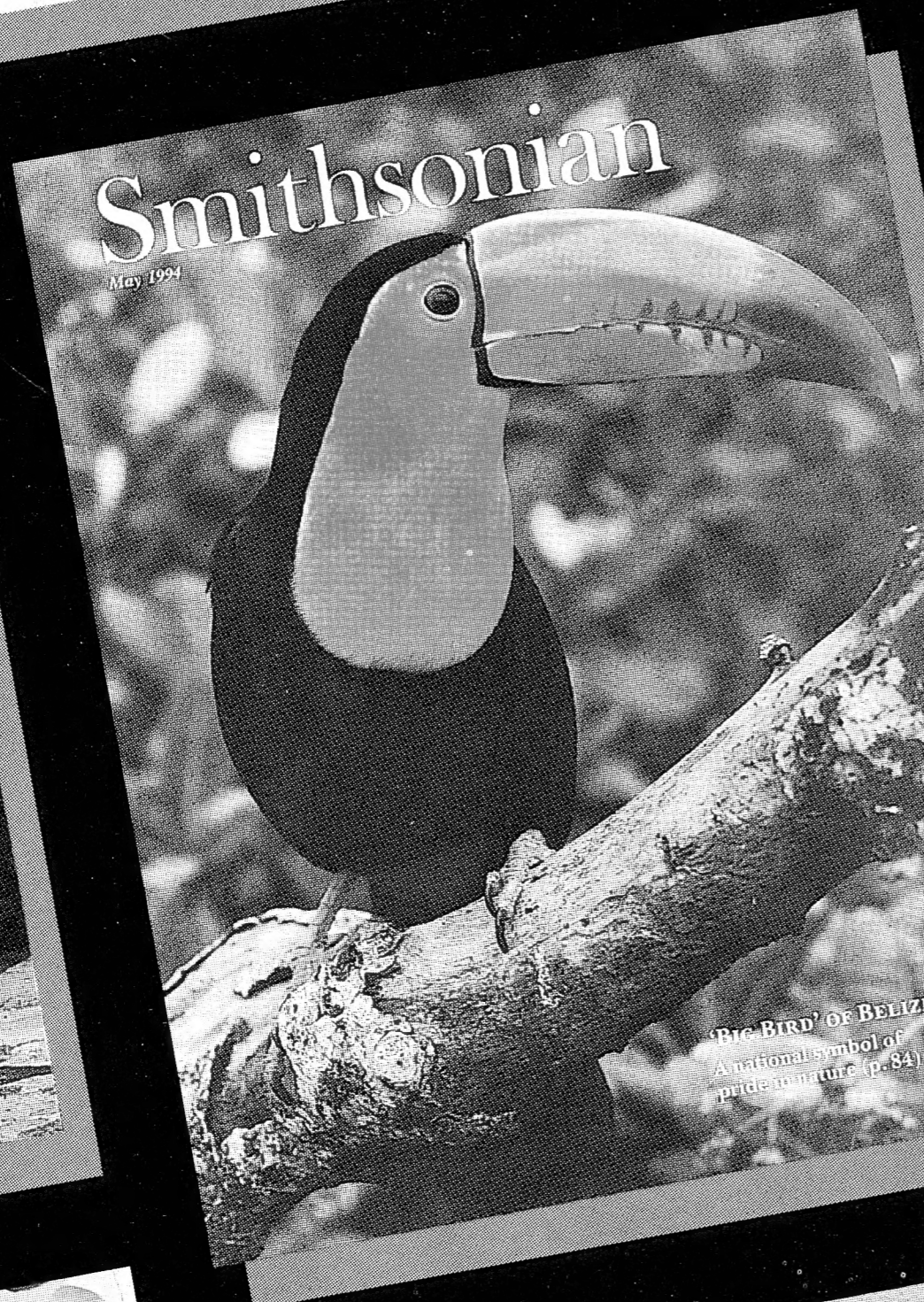
Call 202.673.4951 to receive Nomination Forms or to discuss Board service with me or a member of the Board. The deadline for submitting nominations is June 23, 1995. Address submissions to:

William H. Berman, Chair, Nominating Committee, FONZ, National Zoological Park, Washington, D.C. 20008.

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Clinton A. Fields
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SEX & THE SPOTTED HYENA

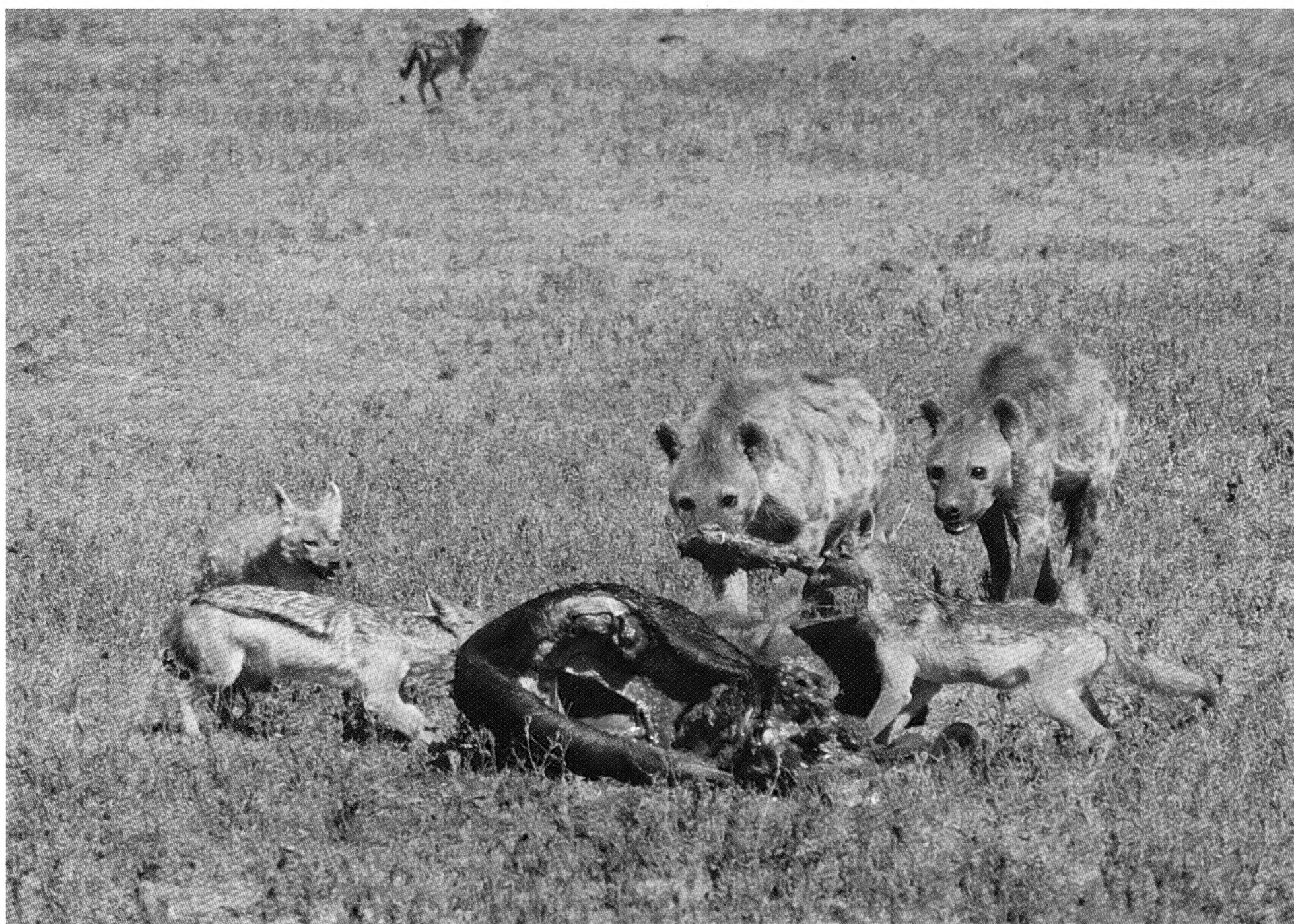
ROBIN MEADOWS

Face to face with the spotted hyenas in the Berkeley hills, I find it hard to believe that these are the fearsome creatures I've been reading about for weeks. Where are the bone-crushing jaws and the propensity for a pack to strip a zebra in 15 minutes flat? These hyenas are fat and friendly, and are clearly interested in their human visitors, in a nonthreatening way. When biologist Laurence Frank enters an enclosure, he is encircled by three exuberant hyenas that look for all the world like large, shaggy, undisciplined dogs in search of love. My daughters and I are equally charmed. After my initial astonishment at the hyenas' amiability, however, I realize that this reception is not at all surprising. Frank bottle-raised this trio, which means he is the closest thing to a mother they have.

In the mid-1980s, Frank and his colleague Stephen Glickman captured 20 infant spotted hyenas in Kenya and brought them home to the University of California at Berkeley. The two researchers rightly anticipated that studies of captive hyenas would unravel the mysteries of these animals, which have been famous since the time of Aristotle for being hermaphrodites.

The misconception that spotted hyenas are bisexual was perpetuated well into the twentieth century by people from Hemingway, who as a writer of fiction can be excused, to biologists, who should have known better. The truth about spotted hyenas (*Crocuta crocuta*) is arguably as bizarre as the myth. To the untrained eye, females look and act almost exactly like males. The two sexes' remarkable resemblance goes right down to the nitty-gritty of their genitals, which appear to be identical. Moreover, the females of this species seem to be even more masculine than the males: Females are some ten percent larger by weight and are so much more aggressive that they dominate males in nearly every social encounter, a fact that the Disney studio paid only lip service to when developing the hyena characters for last summer's animated movie "The Lion King." While the hyenas' ringleader was indeed female, her goofy sidekick should have been named Edwina rather than Ed. The Disney studio had ample opportunity to get it right because a team of illustrators came to Berkeley to sketch Frank and Glickman's brood.

More than mere curiosities, spotted hyenas



Alan K. Mallams

Two spotted hyenas close in on a carcass in Tanzania's Ngorongoro Crater, while black-backed jackals (Canis mesomelas) hurry to tear away what they can.

challenge the conventional wisdom of what makes us female or male and so can give us insights into the limits and latitudes of our own sexuality. Many biologists who study female-male differences let their preconceptions affect their results. For instance, while testosterone and other so-called "male" hormones are quite common in female mammals, biologists almost always focus on their estrogen and other so-called "female" hormones, notes Frank.

Despite their dog-like appearance, the three species of hyenas belong to a superfamily that includes cats, mongooses, and civets. Spotted hyenas are named for the dark brown spots that stand out against their short, brownish-yellow fur. The demented-sounding cackle they make when squabbling gives them their other common name, the laughing hyena. Spotted hyenas live in the savannas and woodlands of sub-Saharan Africa, and their range overlaps with those of the other two species of hyenas, the striped and brown hyenas (*Hyaena hyaena* and *Parahyaena brunnea*). All three species have the long necks, powerful shoulders, and short hindlegs that give hyenas their character-

istic attenuated look. Likewise, all hyenas are consummate scavengers, noteworthy for being the only carnivores that can ingest a carcass in its entirety. While carnivores' digestive tracts are typically short, those of hyenas are uncommonly long and are capable of extracting nearly all the protein and fat from bones. The mineral components of bone are reduced to a fine powder that is excreted, while the hair, ligaments, and other undigestible body parts are regurgitated in a pellet.

Spotted hyenas are distinguished from their relatives in two major ways. While striped and brown hyenas supplement their diets by catching small prey from insects to foxes, these species are predominantly scavengers. In contrast, spotted hyenas hunt for most of their food and usually prey on large animals. A single spotted hyena can catch an adult wildebeest after chasing it three miles at speeds of up to 35 miles per hour.

The second major difference is, as already mentioned, that female spotted hyenas have in many ways adopted the orthodox male role. Female spotted hyenas bear, suckle, and care

for their young like any female mammal. But although their genitals are clearly female in function, they are male in form. The labia are fused into what looks like a scrotum, complete with two pads of fatty tissue that resemble testes. In addition, the clitoris is elongated to the point that it is nearly the size of a male's penis and is likewise fully erectile. Astonishingly, females mate and give birth through the long, narrow canal running down the center of this "pseudopenis." During mating it retracts much like a shirt sleeve being pushed up, and during birth it stretches so much that it looks like a water balloon. "From a human perspective, the process can be thought of as giving birth through an unusually large penis," says Frank.

While highly unusual, spotted hyenas are not as anomalous as they appear to be at first glance. Rather, they are at the extreme end of a continuum of female mammals with masculine characteristics. One-quarter of mammalian families contain species in which females are larger than males, and there are other female mammals with genitals that are masculinized to some degree. For instance, spider monkeys have a large, pendulous clitoris and the European mole has an elongated penis-like clitoris.

In addition to having male-like genitals, female spotted hyenas enjoy the social position accorded to males in most mammal species: dominance. Except for when they are ready to mate, female spotted hyenas completely dominate the adult males that join their clan. (As is true of many social mammals, female hyenas stay in the clan where they were born while males disperse when they reach puberty at about two years of age.) Most tellingly, males abandon kills once females show up—Frank has seen a single juvenile female keep five full-grown males from feeding on a buffalo carcass. Males typically skirt the edges of kill sites, snatching scraps dropped by females.

Aggression is a way of life for female spotted hyenas. "Rank is inherited from mothers, and higher-ranking females teach youngsters what their rank is through aggression," says Frank. "A mother-daughter pair or two sisters will attack a subordinate when her young are around [which teaches the subordinate's young where

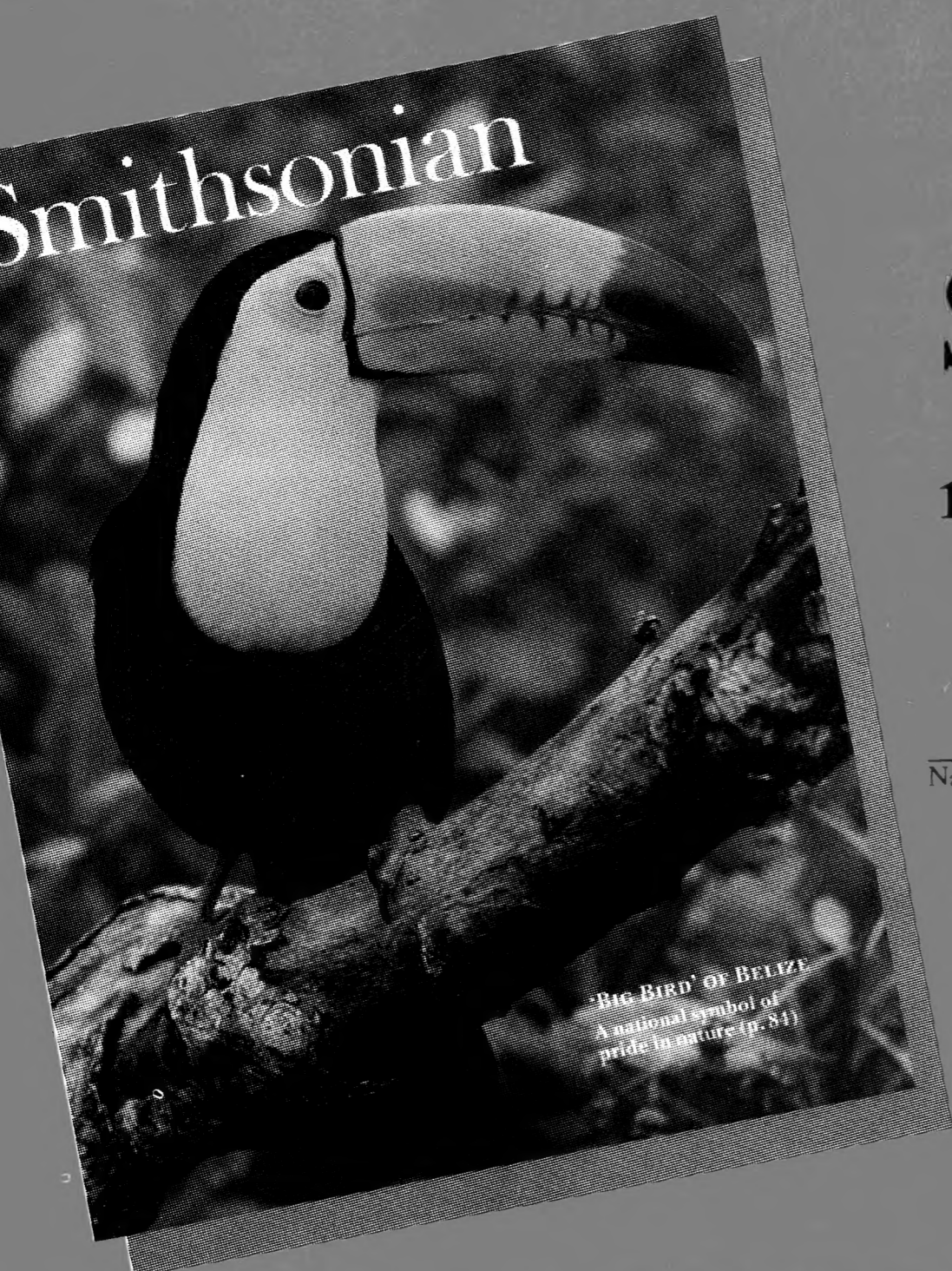
they stand]." Dominant females threaten a subordinate by walking toward her shoulder-to-shoulder with their manes and tails raised.

While many such displays are just meant to show who's boss, subordinates sometimes sustain considerable damage. After being separated for a few hours, spotted hyenas engage in "greeting" displays that entail lifting their legs and exposing their erect pseudopenises for inspection. Subordinate females often initiate greetings and this is the only known case of an erection being a submissive gesture. "This unusual display is not without its risks [because] each hyena puts its reproductive organs in immediate proximity to very powerful jaws," says Frank. "On the rare occasions when the aggression escalates to fighting, the resulting damage may be severe enough to destroy or seriously compromise the reproductive competence of the injured party."

The big questions about spotted hyenas are obvious. Why do the females sport such extraordinary anatomy and behavior? And why are hyenas the only mammals with females that are masculinized to such an extreme degree? Attempts to answer the first question were confounded until Frank, who coordinates the field work, and Glickman, who directs the project, established their hyena colony. Studies on the 40-odd captive hyenas are explaining the physiological basis of behaviors that Frank and his colleagues have seen in their 16-year field study of spotted hyenas in the Talek clan living in Kenya's Masai Mara National Reserve.

One of Frank and Glickman's most striking findings is that compared to males, female spotted hyenas have much higher blood levels of a steroid hormone called androstenedione, which is an androgen or classically "male" hormone. Androstenedione is particularly interesting because it can be metabolized into either the "male" hormone testosterone or the "female" hormone estrogen depending on what enzyme is present: One enzyme converts androstenedione to estrogen, while another converts it to testosterone.

Placentas typically contain both enzymes but Glickman, University of California at Berkeley endocrinologist Paul Licht, and colleagues at the University of California at San Francisco



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Alan K. Mallams

A spotted hyena and two cubs rest at a den entrance.

found that the balance is skewed in spotted hyenas. Human placentas (and presumably those of most mammals) convert maternal androgens to estrogen, thus protecting female fetuses from being masculinized. Spotted hyena placentas, on the other hand, actually convert the maternal androstenedione to testosterone.

Testosterone's effect on female fetuses has been well-documented in laboratory studies. Prenatal exposure to testosterone in female rats, dogs, and monkeys causes male-like genitals as well as increased body size, aggression, and dominance—in short, the suite of characteristics found in female spotted hyenas.

However, science is just like any other part of life in that the answers are not always easy. As the pundits say, there are three kinds of logic: deductive, inductive, and “seductive,” that is, plausible but not necessarily true. The third kind of logic may apply to the argument that female spotted hyenas are masculinized due to prenatal exposure to testosterone. “Everything we know about sexual differentiation is simple: Testosterone makes males,” says Frank. “But because of a whole series of hints, it looks

like that may not be the whole picture in spotted hyenas.” One of these hints is that treatments that reduce penis size in other species—prenatal exposure to compounds that inhibit androgens, and castration before puberty—have little effect on genital size in either sex in spotted hyenas. Such findings have led the researchers to speculate that, “an as yet undiscovered novel mechanism may contribute to sexual differentiation in this species.” That is, the answers are not yet in on what separates the girls from the boys.

Frank and Glickman's studies of the captive spotted hyenas have also led to the surprising discovery that they fight violently at birth. The young of predatory birds including boobies, eagles, and egrets are known to attack and ultimately kill their younger siblings soon after hatching, which may be because the second egg serves only as parental insurance in case the first fails to hatch. However, this is the first such case known in mammals. Spotted hyenas typically give birth at the mouths of abandoned aardvark burrows, which are filled with passages that narrow as they diverge from the

entrance. While the burrows protect the babies from lions and other hyenas, the narrow passages also prevent the mother hyena from reaching her cubs. When ready to nurse, she lies at the entrance and makes a low, groaning sound to call her babies to the surface. After the baby hyenas have lived in the security of their burrow for a few weeks or so, their mother carries them to a communal den shared by other hyena young.

Although spotted hyenas usually have twins, observations during the first decade of the Talek clan field study showed that mothers brought many more single cubs to the communal den than expected. Instead of being mostly twins, by a few weeks of age, more than 40 percent of the litters comprised lone cubs.

What was happening during those initial weeks in the aardvark burrows where the cubs were born? Because the narrow passages make the burrows inaccessible to predators and biologists alike, Frank was unable to solve this puzzle until the first hyenas were born in the Berkeley colony. Then he saw that unlike most carnivores, which are helpless at birth, spotted hyenas are born with both the equipment and inclination to attack. Their eyes are open, their incisors and canine teeth are fully erupted, and they are able to bite within minutes of birth. And bite they do, dotting each other's shoulders and necks with tell-tale puncture wounds until dominance is established. This aggression notwithstanding, spotted hyenas don't kill their siblings directly. Rather, the subordinate sibling is so cowed by the constant attacks that it stays away from the burrow entrance and so from its mother, which means it ultimately starves to death. In the wild, as many as one-quarter of all cubs apparently die in the depths of their natal aardvark burrows.

While Frank and Glickman have made considerable progress in determining the physiological basis for the female spotted hyenas' masculinization, the answer to why spotted hyenas are the only mammals with females that are so extremely masculinized is not as clear. The generally accepted theory is that the masculinization is a consequence of the species' highly competitive communal feeding. Higher-ranking females and their young get to

eat first, and the argument goes that this favors increased aggression in females, which in turn favors increased "male" hormones in females. According to this scenario, the females' masculinized genitals and intense aggression from birth are just side-effects of the increased androgens. However, Frank cautions that many other carnivores also eat together, suggesting that competition for food is not the only reason behind the female spotted hyena's masculinization. "The ancestral spotted hyenas' endocrinology must have preadapted them to this development," says Frank.

Whatever the cause, female masculinization is apparently a very successful strategy for the spotted hyena, which is the most abundant large predator in its range. But this success comes at a cost that is tremendously high for the spotted hyena—and presumably prohibitively high for other species. Notably, giving birth is difficult and dangerous, especially for first-time mothers. The fact that the pseudopenis has such a long, narrow birth canal is enough to make it a poor organ for delivering a baby. But there is the added complication that the end of the pseudopenis cannot stretch enough to accommodate passage of the baby: In a first-time mother, the baby tears its way out. "It's the only time I've ever heard hyenas cry out in pain," notes Frank.

Even worse, the umbilical cords are so short that many first-born babies die. At only six inches long, the umbilical cord is far too short to traverse the foot-long canal down the pseudopenis, which means that either the placenta detaches or the cord breaks before the baby is born. (For comparison, in women the birth canal is only a few inches long and the umbilical cord is a generous foot and a half long.) The longer a hyena's labor, the more likely her baby is to suffocate and be still-born—and the more likely the mother is to die. In captivity, first-time mothers labor as long as 48 hours and nearly three-quarters of first-born cubs die. Without veterinary help, many of these mothers probably would have died along with their babies; in the wild, many females die at three to four years, the age when hyenas typically first give birth.

The high rate of siblicide is another signifi-



Alan K. Mallams

Flamingos provide a colorful backdrop for a resting spotted hyena.

cant cost to the female spotted hyena's masculinization. Producing babies that die shortly after birth is a tremendous waste of a mother's energy. Intriguingly, female spotted hyenas have apparently managed to wring what advantage they can out of their babies' inclination to kill each other. Frank believes that mothers use siblicide to manipulate the sex ratio of their offspring.

It is well known that many female mammals bias the sex ratio of their offspring. Biologists speculate that, for example, having sons may be advantageous to bushbabies, muskrats, and other species in which daughters grow up to share territories with—and so compete for resources with—their mothers. Frank found that high-ranking females in the Talek clan generally raised more sons than daughters when the population of the clan was high. But since 1990, when about a third of the adult females left to establish a new clan, high-ranking females in the Talek clan have raised more daughters than sons.

However, while most species somehow adjust the sex ratio before their babies are born,

spotted hyenas appear to adjust the sex ratio of their babies after birth. Frank has seen that in the wild, female spotted hyenas sometimes put newborn twins into separate aardvark burrows, which keeps the babies from fighting and so greatly increases the likelihood that both will survive. The implication is that mother hyenas can intervene and save their babies if they are the desired sex.

Ever since they were mistaken for hermaphrodites, spotted hyenas have been among the most misunderstood species on earth. Most people follow the lead of the Disney scriptwriters and cast hyenas as the bad guys of the animal world for their gruesome lifestyles. But as Frank and Glickman's work shows, the qualities for which they are reviled seem to arise from a noble goal: Like any mothers, the female hyenas are just trying to provide the best for their children. As for the rest, spotted hyenas, like many of us, are largely captives of their biology.

Robin Meadows is a contributing editor to ZooGoer.

The rugged beauty of the Marine Corps' Camp Pendleton provides not only important training and practice grounds for troops—the property spans 126,000 acres, much of which makes up the largest remaining stretch of wildlife habitat between Los Angeles and the Mexican border.





DEFENDING THE ENVIRONMENT

JEFFREY P. COHN

Slader Buck stands atop a tall mesa at Camp Pendleton, halfway between Los Angeles and San Diego. All around are mountains, hills, and canyons covered with California chaparral and coastal scrub. Riparian woodlands, cattail marshes, and a saltwater estuary mark the Santa Margarita River as it winds its way to the Pacific Ocean.

"This is the closest to a national wildlife refuge that we have," says Buck, natural resources manager at Pendleton, the Marine Corps' main amphibious warfare training center on the West Coast. "We're the last large, relatively undisturbed coastal habitat for wildlife between the Mexican border and Los Angeles."

Camp Pendleton features 250 bird, 60 mammal, and 45 reptile and amphibian species. Coyotes, pumas, foxes, mule deer, opossums, and an introduced bison herd roam the base's 126,000 acres. Pendleton's 17 miles of undeveloped coastline offer nest sites for one-fifth of the endangered California least tern population, and its riparian woodlands harbor almost half of the nesting population of the endangered least Bell's vireo.

When most people think of natural lands with abundant wildlife and protected endangered species, images of wildlife refuges, national parks, and other preserves come to mind. But the Department of Defense (DOD) manages more than 25 million acres nationwide—an area about the size of Virginia—and some DOD facilities encompass more land than most wildlife refuges or national parks do. Eglin Air Force Base near Pensacola, Florida, for example, totals 464,000 acres. The Naval Air Weapons Station at China Lake, California, adds 1.1


million acres, and the Army's White Sands Missile Range in New Mexico, 2.2 million acres, nearly the size of Yellowstone National Park.

Once remote, many military facilities are now surrounded by rapidly expanding cities and suburbs. Take the Army's 79,000-acre Aberdeen Proving Ground north of Baltimore. "If we weren't here, this land would be marinas and condominiums," says James Bailey, an Army wildlife biologist. Instead, Aberdeen boasts the largest population of bald eagles on the northern Chesapeake Bay.

"We've got more endangered species per acre than any other federal land management agency," says Phillip Pierce, an Army natural resources officer in Arlington, Virginia. "Our bases are islands of protected species. They probably hold more species today than when we acquired them."

The reason: Most land on military bases remains in a natural state. More than 90 percent of the Army's Yuma Proving Grounds' 835,000 acres in southwestern Arizona is undeveloped. At Avon Park, Florida, only 3,000 acres of a 106,000-acre Air Force base and bombing range south of Orlando are used. And, at Fort Sill, Oklahoma, where the Army trains its artillery forces, 86,000 of the base's 94,000 acres are wild.

Large expanses of land are needed as buffer, safety, or security zones, says Lt. Col. Tom Lillie, an Air Force program manager for natural and cultural resources at the Pentagon. For instance, the Air Force bombing range in Dare County, North Carolina, has an undeveloped



The gray fox (Urocyon cinereoargenteus) finds refuge in habitats protected at the Marine Corps' Camp Pendleton in southern California, and at other military installations.



Desert tortoise (Gopherus agassizii) populations have nose-dived north and west of the Colorado River, but efforts underway at four Department of Defense bases help give these beleaguered reptiles a better chance for survival.

© Philip Rouillard

41,600-acre safety area around two 2,500-acre target zones.

Not only is land preserved on military bases, but access is often limited. "Military installations are not national parks or zoos," says Junior Kerns, president of the National Military Fish and Wildlife Association and a wildlife biologist at the Yuma Proving Ground. "We can close off areas without going through public hearings."

Access to environmentally sensitive areas may be further restricted. A sign alongside a fenced-off beach at Camp Pendleton, where California least terns nest from May to August, warns people to keep out "by order of the base commander." And the sign is obeyed. "Marines are used to following orders," Buck notes.

On the other hand, natural does not mean unused, especially where ground troops operate. "All of our land may be used for training," Buck says. "That's our mission. We're not a national park. It's not vacant land to us."

Nor does natural, in most cases, mean pristine. Some bases were once heavily logged forests or worked-out farms. Others, like the Rocky Mountain Arsenal near Denver, now a thriving national wildlife refuge, contain leftover chemical wastes and toxic pollutants. Elsewhere, troops conduct training maneuvers and fire live artillery, tanks and other vehicles rumble over the ground, and planes drop live and inert test bombs.

Troops need to train on terrain they are likely to encounter in a real war. "In the long haul, if we don't conserve the natural quality of the land, our ability to train

soldiers will be compromised," says the Army's Pierce. "We have to be good stewards of the land. The public will not accept any less or give us any more."

Nevertheless, natural resource programs traditionally took a back seat to the military mission. "Once we did little except run the deer hunts and manage the herd," Aberdeen's Bailey says. "Now we're responsible for preserving endangered species and restoring wetlands. We are no longer a distant second."

LEAN, GREEN CONSERVATION MACHINE

For years, the only money to fund wildlife conservation came by selling logging, farming, or grazing rights on military lands. The Sikes Act of 1960 extended that concept by authorizing DOD to collect fees for hunting and fishing on military bases, with the income used to fund natural resource programs. The Act also required DOD to cooperate with the U.S. Fish & Wildlife Service (USFWS) and state wildlife agencies.

More recently, Congress created the Legacy Resource Management Program. Starting with \$10 million in 1991, DOD's legacy program provided \$50 million last year to fund projects aimed at preserving wildlife and other natural, anthropological, or cultural resources on military lands.

"Legacy is a godsend," Kerns says. "It pumps money into DOD's wildlife conservation programs that other agencies do not have. Now we have money specifically targeted to wildlife research. It allows us to take advantage of the fact that our military bases are mini natural

A dozen Department of Defense bases are battling to save the red-cockaded woodpecker (Picoides borealis), a species that can nest only in mature southern pine forest.





*Bison
(Bison bison)
roam the range at
Camp Pendleton.*

Slader Buck

laboratories.”

“We’re doing more natural resources work than most national parks or wildlife refuges,” adds Robert Progulske, a wildlife biologist at the Avon Park Air Force Base in Florida. “We have more money than they do.”

Though it’s hard to ascertain exactly why or when, DOD gradually realized sometime in the 1980s that it had to comply with the Endangered Species Act and other environmental laws. Previously, the military often evaded them by citing “national defense.” The 1992 Federal Facility Compliance Act made DOD and all other government agencies subject to hazardous-waste and, by implication, other environmental laws as well.

As a result, “there’s been a change of attitude from the secretary of defense on down,” says Kerns. “To be found not complying with environmental laws has become a source of embarrassment.” It can also result in criminal charges, fines, and stoppage of military activities.

Two recent cases illustrate this point. Three civilian Army employees at Fort Benning, near Columbus, Georgia, were charged in 1992 with conspiracy to violate the Endangered Species Act, a felony. They had designated some of the base’s extensive pine forests, including habitat for endangered red-cockaded woodpeckers, for clear-cut logging. Under the terms of a pretrial agreement, two of the employees were fined, and one was reassigned to other duties, while the other retired. Charges against the third employee were dropped. Although the Fort Ben-

ning case involved civilians, it “sent a message through the military [that] this is not the way to do business,” says Philip Laumeyer, a field supervisor in the USFWS’s Brunswick, Georgia, office.

Second, the commander and another officer at Fort Monroe in Hampton, Virginia, were officially reprimanded in 1994 for ordering base workers to destroy yellow-crowned night heron nests. The nests were knocked down because heron droppings defiled lawns, roads, and cars. The birds were not harmed nor are they endangered, but they are protected under the Migratory Bird Treaty Act.

Beyond any civil penalties, such reprimands can affect an officer’s military standing. “It could end a career, especially during times of downsizing,” Kerns says. “Officers can’t afford even a hint of blemish on their record.”

Most now seem to understand the need to obey wildlife laws. “We hammer home the message that you need to consult with us,” says Tom Campbell, a biologist at the Navy’s China Lake weapons station. “Some don’t like it, but they have bit the bullet. We have the commander’s support, so people pay attention.”

It shows. Today, DOD employs about 6,000 people, mostly civilians, in environmental programs. That includes about 300 wildlife biologists and natural resource managers. They develop species and habitat management plans, educate the military, conduct surveys, oversee research, and work with their counterparts in other federal and state agencies as well as private conservation groups.

A symbol of healthy wildland, the puma (Puma concolor) haunts a number of western military bases.



Doug Padley

DESERT DASES

Four DOD bases in California's Mojave Desert—the Navy's China Lake, the Marines' Twentynine Palms, Edwards Air Force Base, and the Army's National Training Center at Fort Irwin—together total 2.6 million acres of some of the nation's best desert habitat.

All four bases are home to the desert tortoise, and all have programs aimed at protecting the tortoise and its habitat. A species that is threatened north and west of the Colorado River, the desert tortoise, one of only three land tortoises in the United States, has declined in number due to habitat loss, the destruction of tortoise burrows by off-road recreational vehicles, and a fatal respiratory disease spread by pet tortoises freed by their owners.

"We're sensitive to our environment," says Roy Madden, a natural resources officer at Twentynine Palms, a 600,000-acre Marine training facility. "We want to protect the tortoise and its habitat. It's an important species in the desert. Military training and tortoise recovery are not mutually exclusive."

The Marines have set aside 6,000 acres for desert tortoises and adopted a management plan for the rest of Twentynine Palms. The designated site contains the highest tortoise density on the base. Off-road vehicles are prohibited, speed limits of 25 miles per hour have been established, and aerial bombing sites moved. Madden has also launched a four-year, \$40,000 test project aimed at re-establishing native plants and restoring tortoise habitat.

For its part, the Air Force has designated 60,000 acres at Edwards as critical desert tortoise habitat. Mark Hagen, a natural resources manager, surveys the base to identify areas requiring tortoise management and to locate burrows. He uses the information to remove any of the reptiles living near pads used to test rocket engines. The tortoises are carefully returned to their burrows following the tests.

Similarly, the Navy has established a 200,000-acre protected zone for desert tortoises at China Lake. Not only must vehicles stay on marked roads, Campbell says, but all work within the area is closely monitored and restricted to pre-approved places. When necessary, Campbell monitors weapons tests to ensure any effects on tortoise habitat are minimal and any leftover explosives and other hazardous debris are cleaned up afterwards.

IN SEARCH OF MATURE PINES

Elsewhere, the military protects red-cockaded woodpeckers and their pine forest habitat on a dozen DOD bases from North Carolina to Florida and west to Texas. Small black-and-white woodpeckers, the birds are named for the red head tufts on males. They nest in cavities in the trunks of mature pine trees. As pine forests have been logged and replaced with farms, cities, and suburbs, the woodpeckers have disappeared from large areas of the southeastern United States.

Following the 1992 Fort Benning incident, the Army adopted guidelines in 1994 for managing red-cockaded woodpeckers on the bases where the birds occur. As a



One strategy that helps preserve red-cockaded woodpecker habitat is prescribed burning, shown here at Eglin Air Force Base near Pensacola, Florida. The burns simulate wildfire by killing vegetation that competes with the flame-resistant pines.

Department of the Air Force

result, nowhere, perhaps, have the Army's guidelines been more eagerly implemented than at Fort Benning.

To enhance and restore woodpecker habitat, the Army burns off shrubs and small trees that can keep the birds from using nest cavities. Fire, says Charles Ford, Fort Benning's natural resource manager, is a natural part of a pine forest. The Army also removes selected hardwood trees to thin the forest so pines can grow large enough for woodpeckers to excavate a cavity. "If it weren't for the Army, we wouldn't have any red-cockaded woodpeckers around here," Ford says.

For its part, the Navy is re-creating habitat for red-cockaded woodpeckers in Charleston, South Carolina. Navy biologists have affixed 16 nestboxes, modified to keep other birds away, to pine trees at the Naval Weapons Station in Charleston. The boxes replace tree cavities lost when mature pines were destroyed by Hurricane Hugo in 1989. The biologists also drilled holes in trees to give the woodpeckers a head start in building a nesthole, which can take two years to complete, and planted pine seedlings on 385 acres to promote new growth.

Navy efforts to protect wildlife sometimes extend offshore. When a female manatee and her calf died in 1990 after being struck by a ship at a submarine base at Kings Bay, Georgia, the Navy redesigned the propellers of its tugboats and other small ships. The new design adds metal bars to prevent the gentle manatees, of which only about 1,200 remain in U.S. waters, from being drawn into ship propellers. None are known to have been killed

by propellers since.

THE WESTERN FRONT

Meanwhile, back on the West Coast, the Marine Corps' Slader Buck faces a different problem restoring least Bell's vireos at Camp Pendleton. Once common in forests along rivers from northern California to Baja, Mexico, least Bell's vireos are now rare due to habitat loss. They were listed as endangered in 1986 when the population dropped to only 300 pairs in California.

One place where least Bell's vireos are making a comeback is Pendleton. For 15 years now, the Marines have protected the Santa Margarita River's riparian woodlands. More important here, they have also trapped and removed brown-headed cowbirds, which are recent arrivals on the West Coast. Female cowbirds lay eggs in vireo and other birds' nests, fooling them into raising cowbird chicks, often at the expense of their own. Least Bell's vireo numbers at Pendleton have risen from 14 in 1980 to an estimated 350 today, nearly half the total U.S. population.

Wildlife conservation on military bases doesn't always involve such instantly recognized endangered species as desert tortoises, red-cockaded woodpeckers, or manatees. Sometimes it involves critters so small one needs a microscope to see them. Such is the case at Beale Air Force Base north of Sacramento. Nearly one-fourth of Beale's 23,000 acres contain scattered vernal pools, saucer-shaped depressions in hard clay soils that collect and temporarily hold water. The pools, mostly gone

Mule deer (Odocoileus hemionus), like their white-tailed cousins to the east, occupy a wide range of habitats, and are found at many western bases.





Life's a beach for nesting California least terns (Sterna antillarum browni), which have disappeared from much of their original range as pristine beachfront has succumbed to a wave of developmental pressures. Today one-fifth of this endangered bird's population nests on Camp Pendleton's shoreline, where its colonies are strictly protected.

B. "Moose" Peterson

from northern California due to farming, hold an endangered fairy shrimp.

Beale not only protects its remaining vernal pools, but has hired biologists to survey them. The information will be used to develop computer-generated maps to identify which pools contain fairy shrimp, says Bruce Reinhardt, Beale's natural resource manager.

Farther south, Navy resource managers are re-creating vernal pools at Miramar Naval Air Station in San Diego. Ninety-seven percent of San Diego's original vernal pools have vanished, replaced by homes, roads, and farms. Of those remaining, four-fifths are found on Miramar's 23,000 acres.

There, in the southern California desert, the seasonal vernal pools hold another endangered species, the mesa mint (*Pogogyne abramsii*), a small, low-lying plant with striking lavender flowers and an aromatic scent. Mesa mints grow only where depressions in clay soils keep moisture from draining into the dry ground.

Navy resource managers used aerial photos to identify sites where vernal pools once existed at Miramar, but were long ago plowed under or paved over. They dug out the pools, carefully leaving any hard clay remaining, then added soil collected from vernal pool sites elsewhere in San Diego that were scheduled for development. As a result, 33 new pools and their mesa mints now dot land at Miramar that had been devoid of them for years.

Yet another, somewhat larger plant is getting a boost at the Dare County Air Force Bomb Range in North

Carolina. Forester Scott Smith has planted Atlantic white cedar, or juniper, trees on a 15-acre test plot in an attempt to reestablish the species. Only ten percent of Atlantic white cedar habitat, which stretches along the coast from New Jersey to Louisiana, remains. Smith hopes to eventually restore 5,000 acres of wetlands, including 2,000 acres of white cedar, on formerly clear-cut land at the Dare County range.

Turning to habitat rather than species conservation, the Navy protects 225 acres of old-growth forest at the Jim Creek Radio Station north of Seattle. A key communications link between naval shore commands and U.S. submarines at sea, the area holds one of the Pacific Northwest's last stands of virgin Sitka spruce, Douglas fir, cedar, and western hemlock, some reaching 260 feet skyward, with trunks measuring ten feet wide.

GIVE AND TAKE POLICY

Some 2,300 miles away, the Air Force has restored 2,000 acres of Louisiana wetlands along the Red River at Barksdale Air Force Base in Shreveport. The Air Force built controls and a pump on existing canals to add 10,000 gallons of water a minute to reflood drained land. As a result, Barksdale now boasts 6,000 nesting white ibises, little blue herons, and other wading birds in an area that had few if any before.

Similarly, at Fort Sill near Lawton, Oklahoma, the Army has set aside 2,000 acres around an artillery firing range. The area is the largest chunk of ungrazed tall grass prairie in the West, says James Gallagher, an Army

The Whiskey-Echo area of Camp Pendleton provides a snapshot example of why military holdings benefit wildlife while providing for national defense.



Slader Buck

wildlife biologist. The preserve provides habitat for white-tailed deer, scissor-tailed flycatchers, and the largest wintering population of northern harriers in the United States.

Habitat preservation is particularly difficult at Fort Sill and at Fort Knox, the Army's tank headquarters south of Louisville, Kentucky. At both bases, heavy tanks, howitzers, rocket launchers, and other vehicles chew up the ground, dig deep ruts, and add to soil erosion. At Fort Knox, where forests rather than prairies prevail, they also bowl over trees and bushes.

To enhance training and preserve the environment, the Army has launched active land-restoration programs at both sites. At Fort Knox, bulldozer crews have restored natural contours on 1,000 acres since 1991. Ditches, some eight feet deep, have been filled and trees and other native vegetation planted, says Albert Free-land, the base's chief environmental manager.

Whatever the benefits for the environment, monitoring wildlife on military bases can sometimes be dangerous. Ask Avon Park's Robert Progulske. Early one Saturday morning, Progulske was on the base's bomb range looking for Florida grasshopper sparrows, an endangered subspecies. Although he had received an all-clear from mission control, a squadron of F-4 fighter planes suddenly roared low and fast overhead, dropping 25-pound bombs all around. "They were not live bombs," Progulske says, "but you're dead if one hits you. I ran as fast as I could."

Such incidents aside, the question remains: How good a job does the military do conserving wildlife and their habitats? "Overall, pretty good despite some problems," says Gene Stout, a wildlife consultant to DOD and

chairman of the National Wildlife Federation's board of directors.

One problem is that there are few wildlife biologists, botanists, or land managers assigned to some military bases. At White Sands Missile Range in New Mexico, for example, the Army currently has only three for the base's 2.2 million acres. "There are so many projects that we have been unable to do," says White Sand's land manager David Anderson, including erosion control, recontouring damaged ground, reseeding with native plants, and being able to get to tests quickly in order to best assess damage. The Army hopes to hire an additional two or three this year, he says.

Another concern is money, especially in an era of downsizing and changing political priorities in Congress. "This is a tough time for defense budgets," Stout says. Also, wildlife conservation ranks a distant last to other environmental programs within DOD. Aberdeen Proving Ground spends \$140 million annually on pollution control and toxics cleanup, but only \$500,000 for natural resources, Bailey says.

Even the legacy program could face a rocky future. "Legacy is not real popular with the military," says one Pentagon insider, "because it represents money pulled out of something else."

Still, the outlook for wildlife on military bases remains good. "We have the habitat," Camp Pendleton's Buck says. "We don't have anything you can't find elsewhere, we just have more of it. We have wild places that don't exist for many species on the outside."

Jeffrey P. Cohn is a freelance writer specializing in zoo and conservation issues.

Paternity Suits Them

Robin Meadows

In the summer of 1992, Thomas Kunz of Boston University and his colleagues netted ten mature male Dayak fruit bats (*Dyacopterus spadiceus*) in Malaysia's Krau Game Reserve. Much to the biologists' surprise, these males were lactating—their mammary glands yielded small amounts of milk when palpated. While male mammals are known to be physiologically capable of producing milk under unusual circumstances such as severe inbreeding or a hormone imbalance, this was the first time lactating males have been found in the wild.

Whether male Dayak fruit bats actually suckle their young remains to be seen. However, the discovery by Kunz and his colleagues raises at least the possibility of a male mammal caring for its young single-handedly, a scenario that had previously been considered impossible. Conventional wisdom has long been that female mammals must necessarily care for their young by virtue of their mammary glands.

But about five percent of mammal species exhibit at least some paternal care. Such behavior is most common among rodents, carnivores, and primates, and the lion's share of species with paternal care are monogamous, an



Gender bender: Male Dayak fruit bats caused quite a stir when scientists discovered they were the first male mammals known to lactate in the wild.

arrangement that may give males a greater assurance of paternity.

Mammalian males can be very dedicated parents. For example, male gray meerkats (*Suricata suricatta*), in addition to feeding, grooming, and guarding their young, will babysit them while females go out to hunt. Among primates, New World monkeys exhibit the most extensive male care. Male golden lion tamarins (*Leontopithecus rosalia*) take over most of the parental duties by the fourth week after the birth of their offspring, including grooming, carrying, and feeding the young insects and other foods. And male prairie voles (*Microtus ochrogaster*), small rodents closely related to the prolific lemming, diligently care for their young, covering them for warmth, grooming them, and retrieving wandering offspring that leave the nest too soon. The extensive parental care given by male prairie voles presumably helps females have litters in rapid succession, which benefits males by increasing their reproductive success.

Unlike mammals, females in other classes of animals are not physiologically bound to care for their young. Even so, females usually provide what care there is in non-mammalian species. But

Charles Francis

there are exceptions to every rule: Males are responsible for all the care in a variety of species ranging from invertebrates and fish to amphibians and birds.

Most invertebrates simply lay huge numbers of eggs and trust that some of the young will survive long enough to reproduce. But among the invertebrates that do guard their eggs and young, there are a handful of species in which the male provides all the care. For example, males always guard the eggs in at least two species of polychaetes, marine worms that use their many-bristled appendages to swim.

In one species, *Neanthes arenaceodentata*, which lives in bays and river mouths in many parts of the world, a female will enter a male's burrow and lay up to 1,000 eggs, losing 85 percent of her body weight in the process. The male fertilizes the eggs, then may eat what is left of his mate to sustain himself during the three or more weeks he guards them. If uneaten, the female dies within a few days anyway. Females, at least under laboratory conditions, live four or five months before laying their eggs and dying, while males live on to breed more than once.

Exclusive male care predominates in another type of marine animal, sea spiders. Found in all seas, these arthropods typically have eight legs and superficially resemble spiders. A male sea spider reaches into a female's ovary and extracts her egg mass with his third pair of legs, which have hooks and adhesive-producing glands that hold the mass. The male then cradles the fertilized eggs against his belly until they hatch, which takes as long as ten weeks in the case of one of the best-known sea spiders, *Pygospion littorale*, a beige, penny-sized species that lives in England's nearshore waters.

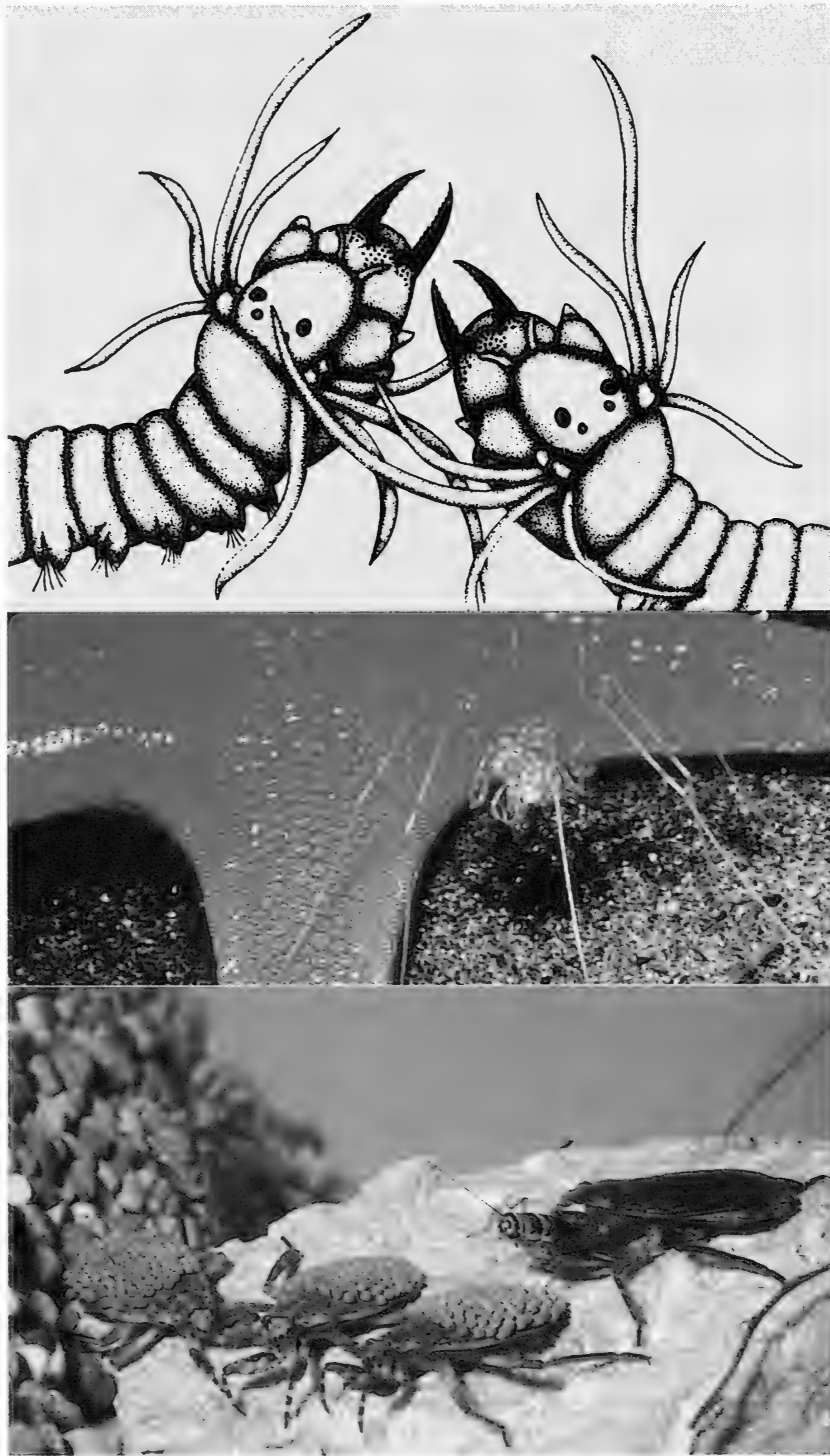
Other species of sea spiders are polygynous and a given male can carry egg masses from more than one female: *Nymphon gracile* males carry up to four egg masses at a time, and *Phloxichi-*

lidium femoratum males carry as many as 14. The theory is that by carrying so many young at once, the males' investment of care yields a profitable return.

Males of some freshwater invertebrates can also carry eggs from more than one female. In the giant water bug (*Abedus herberti*), a brown, inch-long creature that lives in shallow streams and ponds in Mexico and the southwest U.S., the male bears the fertilized eggs on his back. A female uses mucus to affix her eggs to his folded forewings, and he tends the eggs by periodically exposing them to the air and by rocking his body up and down, which pumps a cleansing stream of water over them. By the time the nymphs emerge at three weeks, the eggs have grown so large that they have effectively tripled the male's weight.

There are also a few examples of terrestrial invertebrates in which the male is the sole caregiver. The first arachnid known to exhibit male care is a daddy longlegs (*Zygopachylus albomarginis*) found on Barro Colorado Island, Panama. The males construct shallow, round nests out of mud and bark on a tree trunk, and after a female lays her eggs in a male's nest she leaves him to guard them until they hatch about 20 days later. During this time, he devotedly picks fungus off the eggs and fends off would-be predators, picking up ants and throwing them out of the nest, and chasing and biting other daddy longlegs. Interestingly, the females of this species actively court males and even fight other females to win them (atypical behavior similar to that found in some fish and birds).

While exclusive male care is rare in most groups of animals, it is common in teleosts (a group containing most bony fish). More than half of the species have some form of parental care, usually egg guarding, and male care is more common than female or shared care. Male fish that guard eggs typically fertilize them externally, and the theory is that this makes the males confident that



A mate can become a meal for the male worm *Neanthes arenaceodentata* (top). Male sea spiders ensure their progeny survive by carrying around their mates' fertilized eggs (middle). Three male giant waterbugs carry fertilized eggs on their backs, while the larger female makes a meal of a cricket (bottom).

they are caring for their own young.

Male fish generally guard their young either by defending territories or nests where females lay eggs or by carrying the eggs around with them. In the four-spined stickleback (*Alpetus vulgaris*), a drab two- or three-inch fish that lives in brooks, males use fine plant material to weave nests that can reach five levels' high. Each level houses the eggs of a different female.

One of the most remarkable methods of egg care is practiced by the splash tetra (*Copella arnoldi*), a three-inch, greenish-gold fish found in the Amazon River basin. This species spawns on leaves that overhang the water: A male and female leap out of the water in unison and adhere to the underside of a leaf by spreading out their fins, which allows the surface tension of the water to hold them up for several seconds. A pair typically makes about ten jumps to lay and fertilize about 100 eggs. Then the female goes on her way while the male stays behind, flicking his tail to splash the eggs about once a minute until they hatch several days later. As in many other species with exclusive male care, a male splash tetra can simultaneously care for several spawns from several females.

Other male fish care for their eggs by carrying them in their mouths or other parts of their bodies. In *Betta anabantoides*, two- to three-inch Indonesian fish with showy iridescent red or blue fins, the female releases her eggs into a male's curled anal fin. After he fertilizes them, she sucks the eggs into her mouth and returns them to the male, who then holds them in his mouth for protection, a behavior called "mouthbrooding." In three species of the South American catfish *Loricaria*, the male carries the eggs attached to his lower lip. And in the *Kurtidae*, a little-known group of fish that live in streams and small rivers along the coast of western Australia, males carry the eggs on a hook that projects

from the back of the neck and over the top of the head.

Perhaps the most famous egg-carrying male fish are the sea horses and pipefish that carry the eggs either attached to their bellies or in brood pouches. Like the Panamanian daddy longlegs, some seahorses and pipefish have reversed sex roles. In the pipefish *Nerophis ophidon*, which live in meadows of eelgrass along At-

lantic and Mediterranean coasts of Europe, females are larger and brighter in color, and actively court males. Sea horses take the sex-role reversal even further: The female inserts her prehensile ovipositor into a male and lays her eggs directly into his pouch, and males of some species actually have "pseudoplasentas" with blood vessels that nourish the young.

As in fish, amphibians with exclusive male care tend to fertilize their eggs externally. For example, the five species of salamanders with male care have external fertilization, while the 12 species with female care have internal fertilization. In addition, most amphibians that care for their young are tropical species that lay their eggs on land; without care, the eggs would dry out and die.

Of the about ten percent of amphibian species with parental care, most guard their eggs. Some species, however, carry their eggs or tadpoles with them. In midwife toads (*Alytes obstetricans*), a gray-green, two-inch European species, males twist strings of 50 to 100 eggs around their hindlegs. A male can carry egg strings from more than one female at a time, and the eggs hatch as he passes along the edges of various ponds.

Males in two types of frogs, *Sooglossus* species and *Assa darlingtoni*, guard the eggs, which are laid on land, until they hatch. The male then secretes mucus that allows the tadpoles to wriggle up his legs

so he can carry his young on his back until they metamorphose into tiny froglets. The tadpoles of these species are endowed with



The males in most species of pipefish and seahorse carry the eggs either attached to their bellies or in brood pouches until they hatch. Shown here is the many-ringed pipefish (*Doryrhamphus multiannulatus*) and the oceanic seahorse (*Hippocampus kuda*).

Aaron Norman

Aaron Norman

enormous yolk sacs that sustain them during the process. Male *Sooglossus* carry their tadpoles on their backs, an adaptation that probably evolved due to the lack of free-standing water in their high mountain forest habitat in the Seychelle Islands, which lie northeast of Madagascar in the Indian Ocean. In *A. darlingtoni*, gray-to-reddish inch-long frogs that live in tropical forests of western Australia, a male carries about ten tadpoles in brood pouches that open on either side of his groin. These pouches, which are part of the frog's lymphatic system, extend along the side and belly, and bulge as the tadpoles grow into frogs.

In contrast to invertebrates, fish, and amphibians, nearly all bird species care for their young. (Exceptions are brood parasites such as the brown-headed cowbird and European cuckoo, which lay their eggs in other species' nests so their young can be raised by the host species, and some megapodes, turkey-like birds such as the Australian mallee fowl, which lays its eggs in large mounds of decaying vegetation that produce heat and incubate the eggs without further parental involvement.) Birds are the only group in which it is most common for both parents to pitch in to care for their young. While females usually are responsible for most of the care, there are some species in which the males single-handedly incubate the eggs and care for the hatchlings.

Exclusive male care is found in ratites (kiwis, rheas, and other flightless species) and some shorebirds that nest on the ground. These birds have young that are precocial, which means that, like ducklings, they are down-covered and able to move freely immediately after hatching. Because precocial young are ready to leave the nest soon after hatching, they require far less care than the young of songbirds and other birds that have young that are altricial—naked, blind, and helpless upon hatching.

Some ratites care for more than one clutch at a time. For example, a male greater rhea (*Rhea americana*), an ostrich-like bird that

lives in the pampas of northern Argentina, can have a harem of up to 15 females that can lay a total of 50 eggs in his nest. After incubating the eggs for about five weeks, the male leads and defends his hatchlings for another few weeks.

The shorebirds with exclusive male care include jacanas, seven-inch birds of tropical wetlands that have long green legs and exceptionally long toes, and phalaropes, sandpiper-like birds that breed near ponds in the northern U.S. and Canada. In the northern jacana (*Jacana spinosa*), a species that lives from Central America to southern Texas, a female defends a territory where as many as four males build nests on floating plants. She lays up to five eggs in each nest, and the males incubate them for four weeks and then defend the hatchlings until they can fly. To distract predators, males crouch and slap their wings and feet against the ground or floating plants. Female jacanas are quite a bit larger than the males and dominate them completely.

In Wilson's phalarope (*Steganopus tricolor*), males incubate several eggs for about three weeks in grass-lined scrapes and then rear their brood. Phalarope females are larger and more colorful than the males, and court them aggressively, often chasing them through the air or swimming near them while puffing out their neck feathers and making a repeated "chugging" call. This nearly complete sex-role reversal (the females *still* lay the eggs) confused early biologists and led John James Audubon to mislabel the males and females in all his phalarope plates.

This all goes to show us that we can't second-guess parenthood in the animal kingdom.

From diligent polychaete fathers to lactating male Dayak fruit bats, we are beginning to understand more about the diverse ways the sexes divide their duties, and with that understanding comes the realization that sometimes fathers prove to be the best mothers.

Robin Meadows is a contributing editor to ZooGoer.



Mario Garcia Paris



Jessie Cohen

The male midwife toad (top) carries around twisted strings of eggs on his hindlegs, depositing young as they hatch at different ponds. Ratites like the emu (left) are among the bird species in which males care for eggs and young. Male gray meerkats (right) babysit their young while females go out to hunt.

notes & news



FONZ's Eggstravaganza

If you haven't already, it's not too late to get tickets to this year's ZooFari—*Toucan Dance*, a celebration of birds. Mark your calendar for Thursday evening, May 18, from 6:30 to 11 p.m. This year's top-flight entertainers will include the Drifters, the Coasters, and the Marvelettes. A huge flock of restaurants—more than 90—will be on hand to dish out their varied fare. And if the music, food, silent auction, sweepstakes (chances to win a safari or cruise), and animal demonstrations aren't enough to entice you, consider that this gala event is FONZ's most important fundraiser of the year, and proceeds benefit the Zoo's conservation, education, and exhibit programs. It's a lark, but it's also for a great cause. Tickets cost \$85 for FONZ members; \$100 for non-members. ZooFari 1995 is being generously underwritten by Black Entertainment Television, Eastman Kodak Company, MIX 107.3 FM, Purina Big Cat Survival Fund, The Coca-Cola Company, and W-USA-TV. For tickets and information, call 202.673.4961.

FONZ Happenings

There's plenty going on at the Zoo in May and June. On Thursday, May 23, primatologist Birute Galdikas will discuss her new book *Reflections of Eden: My Years with the Orangutans of Borneo* in the Education Building. Booksigning begins at 7 p.m.; the talk starts at 8 p.m. To reserve a space, call 202.673.4801.

Don your running shoes for the next event: **Running Wild at the National Zoo**, FONZ's annual 5k run, which will start with the crack of the starting gun at 7:30 a.m. on Saturday, June 3. Registration for the race is \$15 before May 26, and \$20 thereafter. This fee includes a race T-shirt and refreshments. Prizes will be awarded to male and female first-place finishers in Open, Masters, and four age-group categories. Proceeds benefit conservation education programs at the Zoo. Call 202.673.4955 to register.

An annual FONZ tradition, **Zoo Night** takes place again on two Friday nights: June 9, for those with last names beginning with A through L, and June 23, for members with names starting with M through Z. Call 202.673.4717 for details.

And starting Thursday, June 29, the Zoo's musical celebration of summer begins with the first of six **Sunset Serenades**.

This series of free Thursday evening concerts runs 6:30 to 8 p.m. on Lion/Tiger Hill. The last concert will take place Thursday, August 3. Concerts will only be canceled by rain at the beginning of, or during, the show.

While strolling through the Zoo, don't forget to stop by The Zoo Store and the Express Grill at Panda Pavilion, which have replaced the Panda Plaza shop and food outlet that closed last year.

The new, larger boutique has a large selection of merchandise, including wildlife-themed toys and clothing, and audio and videotapes. The new carry-out restaurant offers a greatly expanded menu that includes grilled burgers, hot dogs, chicken sandwiches, salads, fries, and ice cream.

Animal News

Golden lion tamarins (*Leontopithecus rosalia*), GLTs for short, will once again haunt the woods of Beaver Valley, where their piercing calls will meld with the daily chorus of resident songbirds. This year a family group will take up residence in the valley, where they will get their outdoor education before being reintroduced into their Brazilian forest habitat in the fall. Expect to see them out and about some time in early June.

A new crop of baby black-tailed prairie dogs (*Cynomys ludovicianus*) is due around the third week in May. Zoo visitors can expect to see baby prairie dogs carousing with adults from June until some time in August, when the young will have grown to adult size and become indistinguishable from their elders.

Other creature features include two yearling male Grevy's zebras (*Equus grevyi*) that have joined the single male at the Cheetah Conservation Station, and three gray meerkats (*Suricata suricatta*), acquired from the Philadelphia Zoo, at the Small Mammal House. The spring baby crop includes baby kowaris (*Dasyuroides byrnei*) at the Small Mammal House, a baby pygmy marmoset (*Callithrix pygmaea*), and four snake-necked turtles (*Chelodina longicollis*) at the Reptile Discovery Center.



Jessie Cohen/NZP

books, naturally

The Beak of the Finch: A Story of Evolution in Our Time. 1994. Jonathan Weiner. Alfred A. Knopf, New York. 332 pp. hardbound, \$25.00. *The Beak of the Finch* is available in the Zoo Bookstore. To order for delivery by mail, call 202.673.4967.



The Beak of the Finch sat on my shelf for several months in the section reserved for the books that I want to read—sometime—but maybe after the new John le Carre, the new Len Deighton, the new P.D. James....After all, a book about finch beaks, not to mention barnacles and soapberry bugs, could hardly be expected to keep you up at night. Fortunately, I started *The Beak* early in the morning because I read this wonderful book straight through, hooked from the first beautifully written pages to the last. This is science writing at its very, very best, about some of the best of

modern biological science.

So what's so fascinating about finch beaks?

Do you see the red line at the beginning of this paragraph? That barely perceptible line is half a millimeter long. Astonishingly, that amount, when added to the depth of a finch's beak, meant the difference between life and death during the worst drought ever recorded on their island home. That silly little half a millimeter gave some finches just the edge they needed to feed more effectively than others on the big tough seeds that became their food of last resort in that long dry year.

The finches that survived the drought were also slightly—five or six percent—bigger than those that didn't make it. And because males are generally about that much bigger than females, many more males than females survived. Of 600 of each sex before the drought, 150 males made it, but only about 25 of the biggest females did. So when the rains finally came and the birds began to breed, just a few of the surviving males got mates. And because female finches prefer to mate with big males, those chosen few were the biggest of the bunch. In turn, the babies they produced grew up to be bigger and have deeper beaks than their pre-drought ancestors.

In just two years, these finches

demonstrated the Darwinian process of evolution by natural selection, with a dose of sexual selection thrown in to complete the picture. Fittingly, this all happened in the Galapagos, in one of the 13 species of diverse finches made famous by Darwin. The very finches that planted the first seeds of an idea that blossomed into a full-blown theory that explains the diversity of life on earth.

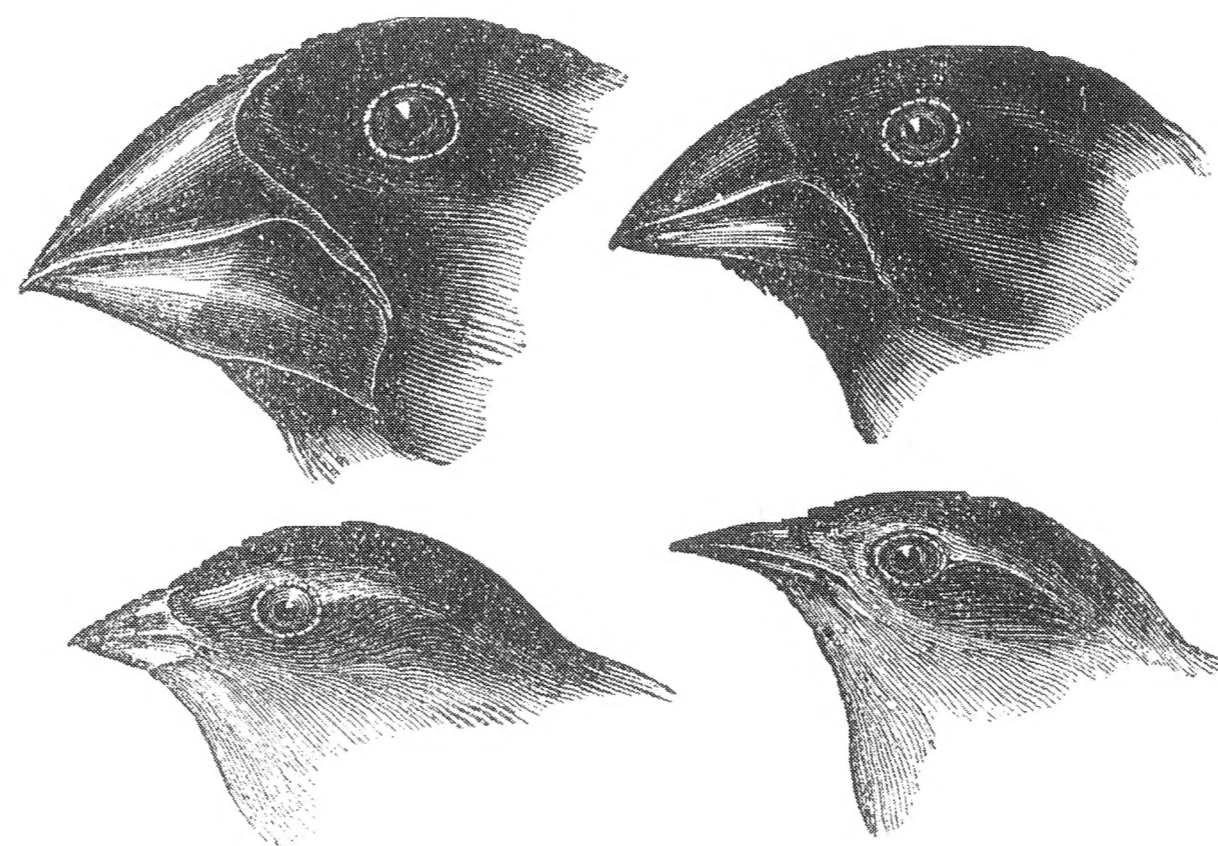
The story of these amazing evolving-before-your-eyes finches and the equally amazing scientists who watched them evolve forms the core of Jonathan Weiner's book. Peter and Rosemary Grant, both Princeton professors, have spent more than 20 years studying Darwin's finches on a tiny uninhabited Galapagos island called Daphne Major. They know these birds intimately, having marked, measured, and tracked the fate of every last finch that has lived and died on Daphne Major during this entire time.

With such complete data, the Grants have provided the best evidence ever that species evolve by the mechanisms proposed by Darwin more than 100 years ago. And while their studies do much to prove Darwin right, they also prove him wrong in one regard. As Weiner puts it, "Taken together, these new studies suggest that Darwin did not know the strength of his theory. He

vastly underestimated the power of natural selection. Its action is neither rare nor slow. It leads to evolution daily and hourly, all around us, and we can watch."

Through Weiner's eyes, we do watch the evolution of finches on Daphne Major, and he makes it a compelling drama as drought and flood, good times and bad times, push the finches first in one evolutionary direction and then in another. You keep reading to find out what finally happens. But one of the points is that you never will find out what finally happens, to these finches or to any species, unless they become extinct. Living things are constantly evolving in response to changing conditions. Until the curtain of extinction falls, the evolutionary play continues without intermission on an ever-shifting stage.

Seamlessly woven into the story of the Grants and their finches is a recounting of Darwin's life, a history of his ideas, and insight into the vociferous opposition to those ideas that still exists today. Weiner cites a poll showing that about half of Americans are creationists, then recounts a study of evolution in a moth that attacks cotton plants. "Some of the greatest opposition to evolution comes from the farmers of the Cotton Belt, and that is where [Princeton scientist Martin] Taylor is seeing one of the most dramatic cases of evolu-



Detail of the heads of four species of Darwin's finches.

From Charles Darwin's *Journal of Researches*, courtesy of the Smithsonian Institution Libraries.

tion in action on this planet." Taylor's study is funded by a pesticide manufacturer, which has literally run out of new chemical weapons to combat the pests—the moths have evolved resistance to all of them and now threaten to wipe out the cotton farmers' crops.

Weiner rounds out his book with brief descriptions of studies of evolution in progress in a variety of species, including those barnacles and soapberry bugs, and, alarmingly, bacteria and viruses. The AIDS virus, for instance, evolves rapidly even within the individual people it infects: "A human body with AIDS is like an entire Galapagos archipelago: it harbors an increasingly diverse group of viruses after the first one has invaded it. The first virus particle to invade evolves into a swarm of variant strains." And therein lies the im-

mense difficulty of finding a cure.

On a lighter note, Weiner tells of an Emory University scientist, Bruce Levin, who watched *E. coli* bacteria evolve in his own gut (he collected his samples on toilet paper) and found that "...the ecology of his gut was hectic, eclectic, and tumultuous. Strains of *E. coli* kept appearing and disappearing." Levin himself says, "[to] see it happen inside you is really kind of awesome. It gives you an eery feeling: when we talk about natural selection, we're not talking about eons here. It's not just dead dinosaurs."

The jacket blurbs promise that *The Beak of the Finch* will change the way we perceive the natural world. This is one of those rare books that actually lives up to such hype.

—Susan Lumpkin



...The Good News

Reduced to fewer than 170 individuals in the early 1970s, only 39 of which were free-roaming, the population of the endangered Cape subspecies of the mountain zebra (*Equus zebra zebra*) has been increasing at approximately seven percent a year, and now numbers over 700. Scientists estimate that at the current rate of increase, a population of 2,500 is feasible by 2013. In Mountain Zebra Park, South Africa, there were a record of 268 mountain zebras as of February, 1994, the result of a steady 13-percent annual increase. And at Karoo National Park, the population has grown annually at ten percent to 106 individuals. Translocations will soon be made to Zuurberg and Bontebok national parks. On a darker note the population of the endangered Grevy's zebra (*Equus grevyi*), the species on exhibit at the Zoo, is shrinking so rapidly that at the current rate of decline, extinction in the wild is probable in the next 50 years.

from *Oryx*, January 1995, and the Equid Specialist Group Newsletter, July 1994

...Bad News

Mammals or birds usually come to mind when we think of extinct species. But fungi? Indeed! British fungus experts (mycologists) speculate that 70 British species are already extinct, and they have red-listed 600 others. Among those listed are the devil's bolete (*Boletus satanus*), which is very rare, and the *Poronia* nail fungus, the most endangered fungus in Europe, which lives on horse dung. It is believed that the declining numbers are the result of habitat destruction, pesticide use, and other forms of pollution. The significance of these fungi may be as difficult for some to see as the fungi themselves. However, some fungi may be, or once were, food sources for insects, while others fulfill symbiotic roles in trees and plants by providing nutrients or preventing infection.

from BBC Wildlife, February 1995

...What's in a Name?

Europeans in the Middle Ages were so smitten by the reddish-orange beetles that protected their crops and gardens from other insect pests that they dedicated the little bugs to the Virgin, or Our Lady, hence the rather respectful name, ladybug. The beetles rid plants, most notably grapevines and citrus trees, of aphids that suck sap from leaves and stems causing destruction of the plants. Ladybugs are distributed worldwide, and roughly 400 species exist in the United States alone. They live in meadows, fields, gardens, and marshes throughout North America, except in the Southwest. Active from May through September, ladybugs hibernate under rocks and fallen branches as the cooler weather sets in. The only character needed to identify some of the more common species is the number of dark spots on the back, which varies geographically. *Coccinella novemnotata*, for instance, translates to nine-marked scarlet berry.

...The Area Scene

For several years now, bald eagles have been nesting upstream from Great Falls in the Chesapeake and Ohio Canal National Historical Park. They are visible with binoculars from the observation deck by the Old Gatehouse on the Maryland side. If all is successful, their young will have hatched by late April and during the next month observers should be able to spot the parents returning to the nest to feed the young. In early June the chicks may take their first flights.

The C & O Canal is bustling with other wildlife activity as well. Around dawn and dusk, visitors to the park might hear the trills of the American toad and gray tree frogs. The two are distinguishable by the pitch and length of the trill. American toads have a longer trill and a fuller voice whereas the gray tree frogs have shorter, richer trills. Also active at these times of day are beavers, and red and gray foxes. During the day you can see painted turtles and northern watersnakes by the canal. In the woods and fields nearby, you might spot black rat snakes, woodchucks, cottontails, and gray squirrels. For park hours and other information, call 301.299.3613.

Urban Animal Safari

The Washington metropolitan area provides ideal habitat for a variety of wild artistic creations. These lively, if inanimate, creatures range all over the region, from our most famous public places to the most secluded private lairs. Pictured here is one of these fantastic animals. Do you know where to spot it? (Look for the answer in our July/August issue.) *Answer to the March/April Urban Animal Safari*: The metal dragonfly is on the wing over the lawn of a private residence on 19th Street, NW.

— Compiled by
Robert Moll



Christy Bowe

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